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Research Article

JOURNAL OF PEDIATRICS, PERINATOLOGY AND CHILD HEALTH

ISSN: 2641-7405

Dietary Intake of Micronutrients and Essential Fatty Acids among Overweight or Obese Pregnant Women during Early Pregnancy

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Abstract

Background: Dietary intake of micronutrients and essential fatty acids in overweight or obese pregnant women during early pregnancy is unknown. We investigated the proportion of pregnant women meeting recommendations for dietary intake of micronutrients and essential fatty acids and compared stress and depressive symptoms between those meeting and below recommendations.

Methods: Participants (N=70) were overweight or obese pregnant women ≤16 weeks gestation. They completed two 24-hour dietary recalls and online surveys measuring stress and depressive symptoms. Micronutrients of interest included B vitamins, choline, and trace minerals (calcium, magnesium, selenium, and zinc). Essential fatty acids were docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA).

Results: Low proportions of participants met recommendations for choline (21.4%) and folate (24.3%). Yet, the proportion of women meeting recommendations for other B vitamins and trace minerals were much better. Less than 9.0% of participants met recommendations for essential fatty acids. Compared with those below recommendations for B3 and selenium, participants meeting recommendations had significantly fewer depressive symptoms.

Conclusions: Low proportions of overweight or obese pregnant participants met dietary intake recommendations for micronutrients and essential fatty acids.

Keywords: Depressive symptoms, Stress, Micronutrients, Trace mineral, DHA, EPA, Ppregnant, Obesity

Introduction

Compared with normal weight women (body mass index, BMI < 25 kg/m^2), overweight or obese women (BMI ≥ 25.0 kg/m^2) are two times more likely to experience excessive gestational weight gain, [1,2] which is associated with adverse maternal and birth outcomes (for example, gestational diabetes, gestational hypertension, preterm delivery). [3,4] It seems logical that reducing gestational weight gain would improve maternal and birth outcomes. However, results of prior randomized controlled lifestyle behavior (diet and physical activity) intervention studies aimed at reducing gestational weight gain in overweight or obese pregnant women have been disappointing. This is because such interventions generally only yield modest intervention effects (reducing gestational weight gain by ~3 lbs), [5] which might not reduce risk for adverse maternal and birth outcomes. [6] Consequently, it raises concerns

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Citation: Mei-Wei Chang, Jonathan Schaffir, Alai Tan, Duane T. Wegener, Katherine Strafford, Brett Worly, Cassandra Sampsell, Maggie Rosen, Loriana Soma. Dietary Intake of Micronutrients and Essential Fatty Acids among Overweight or Obese Pregnant Women during Early Pregnancy. Journal of Pediatrics, Perinatology and Child Health. 7 (2023): 55-62.

Received: March 20, 2023
Accepted: March 28, 2023
Published: March 31, 2023

fortune Journals
Chang M, et al., J Pediatr Perinatol Child Health 2023
DOI:10.26502/jppch.74050145

about the focus on caloric intake and physical activity to improve maternal and birth outcomes among overweight or obese pregnant women. Growing research has indicated the need to investigate daily dietary intake of micronutrients and essential fatty acids among pregnant women, because they have been associated with adverse maternal and birth outcomes.

Maternal intake of micronutrient and essential fatty acids during pregnancy (hereafter, maternal intake) play crucial roles in fetal brain and neural development, epigenetics, disease development later in offspring's life, [7-9] and maternal and birth outcomes. For example, inadequate maternal intake of vitamin B2 (riboflavin), B6 (pyridoxine), and B12 (cobalamin), selenium, and zinc are associated with increased risk for gestational hypertension, [10] preeclampsia, [10-12] and preterm delivery. [10,11,13] Also, inadequate maternal intake of B2, B3 (niacin), B9 (folate), and B12 are associated with heart defects at birth. [14] Moreover, inadequate maternal intake of essential fatty acids (such as docosahexaenoic acid, DHA, and eicosapentaenoic acid, EPA) have been associated with preterm birth. [15]

In addition to maternal and birth outcomes, inadequate micronutrient intakes have been linked with poor mental health in non-pregnant populations. For example, inadequate intake of B vitamins, magnesium, or zinc increases risk for higher levels of stress, [16] and more depressive symptoms. [17-19] Also, inadequate intake of essential fatty acids has been associated with more depressive symptoms. [20,21]

Depending on the types of micronutrient, 7.9-97.2% of pregnant women (regardless of their weight or trimester status) have daily dietary intake of micronutrients meeting Estimated Average Requirement (EAR) and Adequate Intake (AI). [22,23] EAR refers to the average daily nutrient intake estimated to meet the requirements of half of healthy individuals within a group in a life stage and sex. [24] A potential risk factor for inadequate dietary intake of micronutrients is higher weight status (overweight or obesity). For example, non-pregnant overweight or obese women were more likely to report inadequate dietary intake of micronutrients (folate, [25] B2, B12, [26] and zinc [27]) than non-pregnant normal weight women. Also, overweight or obese pregnant women tend to have lower plasma folate, B2, and B12. [26]

In summary, inadequate maternal dietary intake of B vitamins, choline, trace minerals (calcium, magnesium, selenium, and zinc), and essential fatty acids (DHA and EPA) are associated with adverse maternal and birth outcomes and might be associated with increased depressive symptoms. Currently, daily dietary intakes of these micronutrients and essential fatty acids in overweight or obese pregnant women, especially those during early pregnancy (≤16 weeks gestation), remains unknown.

Therefore, the objectives of this study were to

1. Investigate the proportion of overweight or obese pregnant women (≤ 16 weeks gestation) meeting recommendations for daily dietary intake of micronutrients and essential fatty acids, and
2. Compare stress and depressive symptoms between those meeting recommendations and those below recommendations. In this paper, we did not include dietary supplement data in our analysis, because our participants did not report taking dietary supplements other than prenatal vitamins.

Materials and Methods

Design: This was a secondary data analysis. We used baseline (cross-sectional) data of a pilot randomized controlled lifestyle intervention aimed at evaluating feasibility of the recruitment, retention, and intervention acceptability by the intervention participants. A detailed description of the intervention and results of feasibility evaluation and health outcomes (primary outcome: gestational weight gain, secondary outcomes: maternal and birth outcomes) have been described elsewhere. [28]

Setting and Participants: A detailed description of the setting, participants, and procedure has been previously published. [29] Clinicians at 5 collaborating prenatal care clinics briefly explained the study purpose to their first trimester pregnant patients followed by referring those who expressed interest in participating to the study office. Next, research assistants used the study criteria to screen potential participants over the phone for qualification. Those qualified to participate in the study attended a virtual informational meeting (about one hour) through Zoom and provided signed electronic consent forms. After that, participants completed baseline measures. Those who completed the baseline data collection and were less than 17 weeks gestation attended a second Zoom meeting to be randomized and enrolled in the study. The recruitment and enrollment took place between February 2021 and March 2022. Eligibility requirements included singleton gestation, gestational age ≤13 weeks (verified by ultrasound) at referral, pre-pregnancy body mass index between 25.0 and 44.9 kg/m^2 calculated using self-reported height and weight, and age between 18 and 45 years old. We excluded women with a history of 3 or more miscarriages, diagnosed type 1 or 2 diabetes or hypertension. The research assistants screened women over the phone for qualification. Qualified and consented women completed the baseline data collection prior to randomization and enrollment. The study procedure was approved by the Ohio State University Institutional Review Board.

Measures

Participants provided demographic characteristics (for example, race/ethnicity, age, education) over the phone and completed online surveys measuring stress and depressive symptoms. The dietary recall data were collected via a website assessment tool.

Stress: We used the Perceived Stress Scale (10 items) with published validity and reliability to measure stress. [30] This survey asks about perception of stressful life situations in the past month, for example, "How often have you felt that you were unable to control the important things in your life?" The responses ranged from 0 (never) to 4 (often). We summed responses to all items so that higher responses reflected higher levels of stress.

Depressive Symptoms: We used the Edinburgh Postpartum Depression Scale (10 items) with published validity and reliability to measure maternal depressive symptoms. [31] The survey asks about depressive symptoms within the last 7 days, for example, "I have felt sad or miserable." The responses ranged from 0 (for example, not at all) to 3 (for example, yes, quite a lot or most of the time). We summed responses to all items so that higher responses reflected more depressive symptoms.

Dietary intake of micronutrients and essential fatty acids: Participants completed two 24-hour dietary recalls within 2 weeks through the Automated Self-Administered 24-hour Dietary Recall (ASA-24) assessment tool developed by the U.S. National Cancer Institute. The ASA-24 self-administered assessment tool utilizes an automated multiple-pass method (for example, probing for frequently forgotten foods) to increase accuracy of dietary recall. [32] This tool has been widely used by researchers in the U.S. and other countries to collect 24-hour dietary recall data. To classify participants into two groups (meeting versus below recommendations), we used various sources to determine appropriate cutoff values for our pregnant participants. We used Institute of Medicine cutoff values of EAR for B vitamins (B1 ≥ 1.2 mg/d, B2 ≥ 1.2 mg/d, B3 ≥ 14 mg/d, B6 ≥ 1.6 mg/d, folate ≥ 520 mcg/d, B12 ≥ 2.2 mcg/d) and trace minerals (calcium ≥ 800 mg/d, magnesium ≥ 300 mg/d, selenium ≥ 49 ug/d, and zinc ≥ 9.5 mg/d). [24] Because there is no EAR recommendation for choline, we used adequate intake (AI) for choline (≥ 450 mg/d). [24] Finally, we applied Food and Agriculture Organization of the United Nations (FAO) guidelines for DHA (200 mg) and EPA (100 mg) recommendations. [33]

Statistical analysis

Descriptive statistics were used to summarize sample demographics, dietary intakes of micronutrients and essential fatty acids, and measures of stress and depressive symptoms. Two sample *t*-tests were used to compare stress and depressive symptoms between those meeting and those below recommendations for dietary intakes of micronutrients and essential fatty acids. All analyses were conducted using SAS 9.4 (SAS Institute, Cary, North Carolina).

Results

Table 1 presents demographics of the study participants (N = 70). The majority of participants were Non-Hispanic White (72.9%), married (90.0%), employed full time (80.0%), and had at least a Masters' degree (51.4%). Of the sample, 67.1% were enrolled during the first trimester (<13 weeks gestation).

Daily Dietary Intakes of Micronutrients and Essential Fatty Acids, Stress, and Depressive Symptoms

Table 2 shows average daily dietary intake of micronutrients and essential fatty acids as well as stress and depressive symptoms, proportion of participants meeting or below recommendations, and comparison of stress and depressive symptoms between groups. Among B vitamins and choline, 21.4-90% of participants met recommendations. The highest proportions of adequate intake were B3 (90.0%) and B2 (87.1%) followed by B1 (77.1%). The lowest proportions of meeting recommendations were choline (21.4%) and folate (24.3%). Among trace minerals, 45.7-

Table 1: Sample Characteristics (N = 70).

	Mean ± SD
Age	32.2 ± 4.0
	n (%)
Race	
Minorities: Hispanic, Asian, Non-Hispanic Black or multi-race	19 (27.1)
Non-Hispanic White	54 (72.9)
Marital Status	
Married	63 (90.0)
Not married	7 (10.0)
Employment	
Employed full-time	56 (80.0)
Employed part-time	6 (8.6)
Unemployed, self-employed, homemaker, and students	8 (11.4)
Education	
Associate degree or less education	7 (10.0)
Bachelor's degree	27 (38.6)
Master's degree or higher education	36 (51.4)
Gestational age (week) at enrollment	
8	1 (1.4)
9	6 (8.6)
10	6 (8.6)
11	18 (25.7)
12	16 (22.9)
13	15 (21.4)
14	7 (10.0)
16	1 (1.4)

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DOI:10.26502/jppch.74050145

Table 2: Average Micronutrient and Essential Fatty Acid Intakes, Stress and Depressive symptoms, Proportion of Meeting or Below Recommendations, and Comparison of Perceived Stress and Depressive Symptoms between Meeting or Below Recommendations (N = 70).

	Mean±SD or N (%)	Stress		Depressive Symptoms	
		Mean±SD	P	Mean±SD	P
All participants	70 (100)	16.99±5.18		6.92±3.12	
B vitamins					
B1 (Thiamin, mg/d)					
All participants	1.70±0.99				
≥ 1.2 mg$	54 (77.14)	16.76±5.25	0.51	6.77±2.86	0.46
< 1.2 mg	16 (22.86)	17.75±5.00		7.43±3.93	
B2 (Riboflavin, mg/d)					
All participants	1.90±0.65				
≥ 1.2 mg$	61 (87.14)	16.89±5.20	0.68	6.72±2.84	0.35
< 1.2 mg	9 (12.86)	17.67±5.27		8.27±4.58	
B3 (Niacin, mg/d)					
All participants	22.47±7.42				
≥ 14 mg$	63 (90.00)	16.86±5.11	0.54	6.67±2.87	0.04
< 14 mg	7 (10.00)	18.14±6.07		9.21±4.43	
B6 (Pyridoxine, mg/d)					
All participants	1.86±0.73				
≥ 1.6mg$	44 (62.86)	16.61±5.65	0.44	7.05±2.87	0.67
< 1.6 mg	26 (37.14)	17.62±4.28		6.71±3.53	
B9 (Folate, mcg/d)					
All participants	417.06±174.34				
≥ 520 mcg$	17 (24.29)	16.24±5.79	0.50	6.21±2.42	0.28
< 520 mcg	53 (75.71)	17.23±5.00		7.15±3.29	
B12 (Cobalamin, mcg/d)					
All participants	4.20±2.32				
≥ 2.2 mcg$	57 (81.43)	17.09±5.22	0.73	6.84±2.93	0.66
< 2.2 mcg	13 (18.57)	16.54±5.17		7.26±3.94	
Choline (mg/d)					
All participants	325.30±144.22				
≥ 450 mg$	15 (21.43)	18.13±5.28	0.34	7.63±2.37	0.32
< 450 mg	55 (78.57)	16.67±5.15		6.73±3.28	
Trace minerals					
Calcium (mg/d)					
All participants	1045.34±405.99				
≥ 800 mg$	48 (68.57)	16.71±5.38	0.51	6.62±2.68	0.31
< 800 mg	22 (31.43)	17.59±4.78		7.58±3.89	
Magnesium (mg/d)					
All participants	296.66±100.03				
≥ 300 mg$	32 (45.71)	15.97±5.68	0.13	6.74±2.68	0.65
< 300 mg	38 (54.29)	17.84±4.61		7.08±3.47	
Selenium (ug/d)					
All participants	112.94±37.72				
≥ 49 ug$	68 (97.14)	16.85±5.19	0.21	6.75±2.91	0.01
< 49 ug	2 (2.86)	21.50±0.71		12.78±5.50	

Zinc (mg/d)					
All participants	11.07±3.99				
≥ 9.5 mg$	46 (65.71)	17.63±5.11	0.15	6.84±2.88	0.76
< 9.5 mg	24 (34.29)	15.75±5.18		7.08±3.59	
Essential Fatty Acids					
DHA (g/d)					
All participants	60±14				
≥ 200 mg$	4 (5.71)	12.75±3.50	0.09	5.28±3.06	0.28
< 200 mg	66 (94.29)	17.24±5.17		7.02±3.11	
EPA (mg/d)					
All	40±11				
≥ 100 mg$	6 (8.57)	14.00±4.38	0.14	5.93±2.78	0.42
<100 mg	64 (91.43)	17.27±5.19		7.01±3.15	

$ Meeting IOM daily dietary intake recommendations for micronutrients. Estimated Average Requirement (EAR) was used for B vitamins and trace minerals. Adequate Intake (AI) was used for choline. The Food and Agriculture Organization of the United Nations guidelines were used for essential fatty acids.

97.1% of participants met recommendations. The highest proportions of adequate intake were selenium (97.1%) followed by calcium (68.6%). Less than 9.0% of participants met recommendations for essential fatty acids. The average intake of DHA (60 [SD =14] mg) and EPA (40 [SD =11] mg) were well below recommendations. In terms of stress, there were no significant group differences in dietary intakes of micronutrients and essential fatty acids. The only significant group differences in depressive symptoms were between those meeting and not meeting recommendations for B3 (P = 0.04) and selenium (P = 0.01).

Discussion

This study was the first to investigate the proportion of overweight or obese pregnant women (during early pregnancy) meeting recommendations for dietary intake of micronutrients and essential fatty acids. We also compared stress and depressive symptoms between those meeting and those below recommendations.

Micronutrients

A prior study of pregnant women with all body sizes and various trimesters revealed that 64.2-97.6% of participants met recommendations for daily intake of B vitamins. [23] However, we found much lower proportions of participants (24.5-87.1%) met recommendations for B vitamins, perhaps because of the overweight or obese status of our participants. [25,26] Adequate intake of folate is critical during the first trimester, especially less than 6 weeks gestation to reduce risk for neural tube defects. [34] Yet, in our sample, less than 25% of participants reported adequate folate intake.

Maternal dietary intake of calcium during pregnancy is important, because inadequate calcium intake can be associated with increased risk for preeclampsia. [35] We found nearly 31% of participants reported inadequate dietary intake of calcium, consistent with a prior study of pregnant women. [36] Adequate intake of choline has been positively associated with fetal neural development. [9] In the present study, approximately 21% of participants had dietary intake of choline that met recommendations, which is much lower than a prior study of pregnant women (approximately 90%). [23] The differences between studies might have been due to timing of data collection. Whereas the prior study used data collected between 2001 and 2014, our data were collected during the COVID pandemic, which might have affected individuals' dietary intake. Zinc is needed for biological processes (for example, DNA and RNA synthesis) that are important for epigenetic mechanism. [37] Also, inadequate maternal intake of zinc might increase risk for gestational hypertension, preeclampsia, preterm delivery, low birth weight for gestational age, and congenital anomalies. [10] Our data showed that approximately 66% of participants met recommendations for zinc, which is similar to a prior study of pregnant women. [23]

Overall, we found that low proportions of the study participants met daily dietary intake recommendations for micronutrients. During prenatal care visits, clinicians commonly prescribe or recommend prenatal dietary supplements that might not contain sufficient micronutrients to meet the needs of pregnant women and their fetuses. [38] Also, benefits of prenatal supplements are limited to specific micronutrients such as folate. [39] Moreover, only 70% of pregnant women reported taking any dietary supplement during pregnancy. [40] Future studies could use focus groups or in-depth interviews to identify barriers to and facilitators for adequate micronutrient intake during early pregnancy among overweight or obese pregnant women. Results of future studies might thereby provide insight and helpful

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DOI:10.26502/jppch.74050145

recommendations for how clinicians can encourage pregnant patients to increase micronutrient intake and how researchers can design interventions to promote optimal maternal micronutrient intake.

Essential Fatty Acids

Consistent with a prior study of pregnant women in all trimesters, [41] we found that less than 9.0% of the study participants met recommendations for DHA and EPA. In the U.S., there is no recommended daily intake of DHA and EPA. However, the Dietary Guidelines for Americans 2020-2025 recommends that pregnant women eat 2-3 ounces of seafood including fish and shellfish per week, because they provide essential fatty acids (DHA and EPA). [34] However, individual preference for seafood and availability varies, and the importance of avoiding fish with high mercury content might dissuade some women from consuming enough fish to get sufficient dietary intake of DHA and EPA. An alternative is to take dietary supplements containing essential fatty acids. Yet, the specific amount of DHA and EPA supplement that would meet the needs of pregnant women remains unclear [41].

Stress and Depressive Symptoms

We did not observe group differences in stress among micronutrients and essential fatty acids, a finding contradictory to findings of a prior study. [16] In terms of depressive symptoms, we found that participants with adequate dietary intake of B3 and selenium were less likely to report depressive symptoms than those with inadequate intake. Yet, we did not detect group differences in depressive symptoms among other micronutrients or essential fatty acids. The latter findings are inconsistent with findings of prior studies. [16-21,42,43] Future research, especially prospective longitudinal or randomized controlled trials are needed to investigate the associations among micronutrients, essential fatty acids, and mental health (stress and depressive symptoms).

Limitations

There are a number of limitations to this study. First, without data on prenatal vitamin or supplement use, it is possible that our data significantly underestimate overall intake of micronutrients and essential fatty acids. If such supplements are treated as sufficient on their own, it could even be that intake through one's regular diet is lower in this population when taking vitamins or supplements than when not. Second, the use of cross-sectional data precludes us from identifying causal effects. Also, the two 24-hour periods of dietary data might not be representative of participants' usual or habitual dietary intake. This is because some participants might have experienced morning sickness, which could have altered or reduced their dietary intake. Consequently, we might have misclassified participants into groups. Therefore, interpretation of the study findings should be undertaken with caution. In addition, the small sample size limited our ability to detect significant group differences in stress and depressive symptoms. Finally, results of this study are not generalizable to other populations, because our sample comprised predominantly non-Hispanic White individuals with advanced education (though intake deficits observed in this group might be even greater in other groups).

Conclusions

Depending on types of micronutrients, we found that anywhere between 21.4 and 97.1% of participants met recommendations for daily dietary intake of micronutrients. Less than 9.0% of participants met recommendations for essential fatty acid dietary intake, however. In general, participants reported similar levels of stress and depressive symptoms, except those meeting recommendations for B3, and selenium for depressive symptoms. Future larger prospective studies are needed to verify our study findings.

Acknowledgement

This research was funded by the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD). Grant number: R21HD099380

Conflicts of Interest

The authors declare no conflict of interest. The sponsor has no role in the design, execution, interpretation, or writing of the study.

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